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6. AUTHOR(S) Prof. James G. Fujimoto			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Research Laboratory of Electronics Massachusetts Institute of Technology 77 Massachusetts Avenue Cambridge, MA 02139		8. PERFORMING ORGANIZATION REPORT NUMBER	
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September 9, 1993

Dr. Clifford G. Lau  
Acting Director  
Electronics Division  
Department of the Navy  
800 North Quincy Street  
Arlington, VA 22217-5660

Dear Dr. Lau:

Following your request, enclosed please find our progress report on our contract N00014-91-J-1956, entitled "Femtosecond Studies of Carrier Dynamics in Compound Semiconductors," Principal Investigators: Drs. James G. Fujimoto and Christopher Stanton. This program is performed under the direction of Dr. Larry Cooper.

Please accept my apologies for the delay in sending this to you as I have just returned from being out of the country for three weeks. Please do not hesitate to contact me should you require any additional information or materials. Thank you for your kind consideration.

Sincerely yours,

*James Fujimoto*

James G. Fujimoto  
Associate Professor of  
Electrical Engineering

JGF:cyk

cc: L. Cooper  
M. Greene ✓  
C. Stanton

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OFFICE OF NAVAL RESEARCH  
PUBLICATION/PATENTS/PRESENTATION/HONORS REPORT  
for  
1 Oct 92 through 30 Sept 93

R&T Number:

Contract/Grant Number: N00014-91-J-1956

Contract/Grant Title: Femtosecond Studies of Carrier Dynamics in Compound Semiconductors

Principal Investigator: Dr. James G. Fujimoto

Mailing Address: Massachusetts Institute of Technology,  
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Phone Number (with Area Code): (617) 253-8528 FAX: (617) 253-9611

E-Mail Address:

- a. Number of Papers Submitted to Referred Journal but not yet published: 7
- b. Number of Papers Published in Referred Journals: 10  
(list attached)
- c. Number of Books or Chapters Submitted but not yet Published: -
- d. Number of Books or Chapters Published: -  
(list attached)
- e. Number of Printed Technical Report & Non-Referred Papers: -  
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- f. Number of Patents Filed: -
- g. Number of Patents Granted: -  
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- h. Number of Invited Presentations at Workshops or Prof. Society Meetings: 4
- i. Number of Presentation at Workshop or Prof. Society Meetings: 13
- j. Honors/Awards/Prizes for Contract/Grant Employees:  
(list attached, this might include Scientific Soc. Awards/Offices,  
Promotions, Faculty Award/Offices etc.)
- k. Total number of Graduate Students and Post-Docs Supported at least 25%, this  
year on this contract, grant:  
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|--|---|------------------------|---------------|
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**OFFICE OF NAVAL RESEARCH**  
**PUBLICATION/PATENTS/PRESENTATION/HONORS REPORT**  
**for**  
**1 Oct 92 through 30 Sep 93**

**R&T Number:**

**Contract/Grant Number:** N00014-91-J-1956

**Contract/Grant Title:** Femtosecond Studies of Carrier Dynamics in Compound Semiconductors

**Co-Principal Investigator:** Dr. James G. Fujimoto

**Mailing Address:** Massachusetts Institute of Technology, Cambridge, MA 02139

**Co-Principal Investigator:** Dr. Christopher Stanton

**Mailing Address:** University of Florida, Gainesville, FL 33611

**Phone Number:** (617) 253-8528

**FAX Number:** (617) 253-9611

**A. Number of Papers Submitted to Referred Journal but not yet published:**

1. A. V. Kuznetsov and C. J. Stanton, "Ultrafast optical generation of carriers in a DC electric field: transient localization and transient photocurrent," accepted for publication in Physical Review B.
2. C. K. Sun, F. Vallée, L. H. Acioli, E. P. Ippen, and J. G. Fujimoto, "Femtosecond investigation of electron thermalization in gold," accepted for publication in Physical Review B.
3. G. D. Sanders, C. J. Stanton, and Y. C. Chang, "Theory of transport in silicon quantum wires," submitted for publication in Physical Review B.
4. B. B. Hu, A. S. Weling, D. H. Auston, A. V. Kuznetsov, and C. J. Stanton, "DC electric field dependence of THz radiation induced by femtosecond optical excitation of bulk GaAs," submitted for publication.
5. C. S. Kim, A. V. Kuznetsov, and C. J. Stanton, "Theory of generation and detection of carriers in ultrafast photoexcitation experiments in semiconductors," submitted for publication.
6. G. D. Sanders, C. J. Stanton, and Y. C. Chang, "Numerical studies of femto-second carrier dynamics in silicon quantum wires," in preparation.
7. G. D. Sanders, C. J. Stanton, C. K. Sun, and J. G. Fujimoto, "Carrier gain dynamics in InGaAs/AlGaAs strained-layer single well diode lasers," in preparation.

**B. Number of Papers Published in Referred Journals:**

1. L. H. Acioli, M. Ulman, E. P. Ippen, J. G. Fujimoto, H. Kong, B. S. Chen, and M. Cronin-Golomb, "Femtosecond temporal encoding in barium titanate," Opt. Lett. **16**, 1984-1986, Dec. 1991.
2. C. de C. Chamon, C. K. Sun, H. A. Haus, and J. G. Fujimoto, "Femtosecond time division interferometry technique for measuring the tensor components of  $\chi^{(3)}$ ," Appl. Phys. Lett. **60**, 533-535, Feb. 1992.

3. D. W. Bailey and C. J. Stanton, "Carrier diffusion effects in time-resolved photoluminescence," *Appl. Phys. Lett.* **60**, 880-882, 1992.
4. C. J. Stanton and D. W. Bailey, "Rate equations for the study of femtosecond intervalley scattering in compound semiconductors," *Phys. Rev. B* **45**, 8369-8377, April 1992.
5. G. D. Sanders, C. J. Stanton, and Y. C. Chang, "Theory of electronic, optical, and transport properties in silicon quantum wires," *Mat. Res. Soc. Symp. Proc.* Vol. 238, 1992.
6. C. J. Stanton and D. W. Bailey, "Coulomb enhancement of the above-band edge pump-continuum probe spectroscopy," *Phys. Rev. B* **47**, 1624-1627, Jan. 1993.
7. C. K. Sun, H. K. Choi, C. A. Wang, and J. G. Fujimoto, "Studies of carrier heating in InGaAs/AlGaAs Strained-layer quantum-well diode lasers using a multiple wavelength pump probe technique," *Appl. Phys. Lett.* **62**, 747-749, Feb. 1993.
8. M. Ulman, L. H. Acioli, F. G. Vallee, E. P. Ippen, J. G. Fujimoto, D. W. Bailey, and C. J. Stanton, "Femtosecond tunable nonlinear absorption spectroscopy in  $\text{Al}_{0.1}\text{Ga}_{0.9}\text{As}$ ," *Phys. Rev. B* **47**, 10267-10278, Apr. 1993.
9. C. K. Sun, H. K. Choi, C. A. Wang, and J. G. Fujimoto, "Femtosecond gain dynamics in InGaAs/AlGaAs strained-layer single-quantum-well diode lasers," *Appl. Phys. Lett.* **63**, 96-98, July 1993.
10. L. H. Acioli, M. Ulman, F. Vallée, and J. G. Fujimoto, "Femtosecond carrier dynamics in the presence of a cold plasma in GaAs and AlGaAs," *Appl. Phys. Lett.* **63**, 666-668, Aug. 1993.

C. Number of Books or Chapters Submitted by not yet published:

D. Number of Books or Chapters published:

E. Number of Printed Technical Reports & Non-referred papers:

F. Number of Patents filed:

G. Number of Patents granted:

H. Number of Invited Presentations at Workshops:

1. C. J. Stanton, "Hot electron effects near the semiconductor interface," 4th Workshop on BEEM, January 25, 1993, Williamsburg, VA.
2. G. D. Sanders, "Electronic, optical, and transport properties of silicon quantum wires-theory," APS Meeting, March 1993.
3. G. D. Sanders, C. J. Stanton, and Y. C. Chang, "Electronic, transport and optical properties of 1-D quantum wires: Applications to porous silicon," Workshop on Optical Properties of Mesoscopic Semiconductor Structures, Snowbird, UT, April 1993.

4. C.-K. Sun, H. K. Choi, C. A. Wang, and J. G. Fujimoto, "Femtosecond carrier dynamics in InGaAs/AlGaAs strained-layer single-quantum-well diode lasers," Workshop on Optical Properties of Mesoscopic Semiconductor Structures, Snowbird, UT, April 1993.

I. Number of Presentations at Workshops or Prof. Society Meetings:

1. M. Ulman, L. H. Acioli, C. J. Stanton, E. P. Ippen, and J. G. Fujimoto, "Studies of intervalley scattering using tunable femtosecond pulses," presented at the Quantum Electronic and Laser Science Conference, QELS'92, Anaheim, CA, May 10-15, 1992, paper QThB4, p. 222.
2. G. D. Sanders, C. J. Stanton, and Y. C. Chang, "Theory of optical gain in silicon quantum wire lasers," presented at the 1992 March Meeting of the American Physical Society, March 16-20, 1992, Indianapolis, IN, paper F19-2.
3. C. J. Stanton and D. W. Bailey, "Rate equations for the study of intervalley scattering in compound semiconductors," presented at the 1992 March Meeting of the American Physical Society, March 16-20, 1992, Indianapolis, IN, paper G20-8.
4. D. W. Bailey, C. J. Stanton, M. Ulman, L. H. Acioli, and J. G. Fujimoto, "Tunable pump-probe nonlinear absorption spectroscopy in AlGaAs," presented at the 1992 March Meeting of the American Physical Society, March 16-20, 1992, Indianapolis, IN, paper G20-7.
5. G. D. Sanders, C. J. Stanton, and Y. C. Chang, "Theory of electronic, optical, and transport properties in silicon quantum wires," Mat. Res. Soc. Symp. Proc. Vol. 238, 1992.
6. D. G. Kobzev, C. J. Stanton, and B. Y.-K. Hu, "The effect of dynamic screening and nonequilibrium carrier distributions on electron-electron scattering of photoexcited carriers," presented at the March 1993 Meeting of the American Physical Society.
7. A. V. Kuznetsov and C. J. Stanton, "Theory of transient photocurrent at semiconductor surfaces under femtosecond optical excitation," presented at the March 1993 Meeting of the American Physical Society.
8. C.-K. Sun, H. K. Choi, C. A. Wang, and J. G. Fujimoto, "Femtosecond carrier dynamics and stimulated transitions induced carrier temperature change in InGaAs/AlGaAs strained-layer single-quantum-well diode lasers," presented at the Conference on Lasers and Electro-Optics, CLEO'93, Baltimore, MD, May 2-7, 1993, paper CThC2, p. 384.
9. F. Vallée, C.-K. Sun, L. Acioli, E. P. Ippen, and J. G. Fujimoto, "Femtosecond investigation of electron thermalization in gold," presented at the Quantum Electronic and Laser Science Conference, QELS'93, Baltimore, MD, May 2-7, 1993, paper QTuF7, p. 69.
10. G. D. Sanders, C. J. Stanton, and Y. C. Chang, "Theory of electronic, optical, and transport properties in silicon quantum wires," Proceedings of the International Workshop on Light Emission and Electronic Properties of Nanoscale Silicon, Charlotte, NC, 1993.
11. C. S. Kim, A. V. Kuznetsov, and C. J. Stanton, "Theory of generation and detection of carriers in ultrafast photoexcitation experiments in semiconductors," Hot Carriers in Semiconductors VIII, Oxford, UK, August 16-20, 1993.

12. C. J. Stanton, A. V. Kuznetsov, and C. S. Kim, "Optical generation and detection of carriers in ultrafast pump-probe spectroscopy of semiconductors," NATO Advanced Research Workshop on Coherent Optical Interactions in Semiconductors, Cambridge, UK, August 11-13, 1993.
13. A. V. Kuznetsov and C. J. Stanton, "Ultrafast optical generation of carriers in semiconductors in a DC electric field," NATO Advanced Research Workshop on Coherent Optical Interactions in Semiconductors, Cambridge, UK, August 11-13, 1993.

J. Honors/Awards/Prizes for Contract/Grant Employees:

1. J. G. Fujimoto was elected Fellow of the Optical Society of America, 1992.
2. C. J. Stanton was awarded the Alfred P. Sloan Foundation Fellowship, 1992.

K. Total number of Graduate Students and PostDocs:

1. Dr. James G. Fujimoto, Associate Professor of Electrical Engineering, Research Laboratory of Electronics, Department of Electrical Engineering and Computer Science, Massachusetts Institute of Technology, Cambridge, Massachusetts.
2. Dr. Christopher J. Stanton, Associate Professor of Physics, Department of Physics, University of Florida, Gainesville, Florida.
3. Dr. Lucio Acioli, Visiting Scientist, (April 1991 - June 1992), Massachusetts Institute of Technology.
4. Dr. Daniel W. Bailey, Postdoctoral Associate, (April 1991 - September 1991), University of Florida.
5. Dr. Gary Sanders, Postdoctoral Associate, (October 1991 - present), University of Florida.
6. Morrison Ulman, Research Assistant, (October 1991 - present) Massachusetts Institute of Technology.
7. Chi-Kuang Sun, Research Assistant, (January 1993 - present), Harvard University Division of Applied Sciences, (working at the Massachusetts Institute of Technology).
8. Dr. Alex Kuznetsov, Postdoctoral Associate, (June 1992 - present), University of Florida.

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